REMARKS

The Examiner has rejected Claims 1-2, 4-5, and 7-31 under 35 U.S.C. 101 as being directed to non-statutory subject matter for failing to produce a tangible result. Specifically, the Examiner has argued that the "claims all appear to include abstract ideas such as generating a solution to a partial differential equation."

Applicant respectfully disagrees and asserts that "generating a solution" (see the same or similar, but not necessarily identical language in independent Claims 1, 10, 11, 26-28 and 30-emphasis added), as applicant claims, clearly discloses generating a tangible result, namely a "solution to the partial differential equation," as claimed. Similarly, applicant respectfully asserts that "computing a solution" (see the same or similar, but not necessarily identical language in independent Claims 29 and 31-emphasis added), as applicant claims, also discloses computing a tangible result, namely a "solution to the partial differential equation," as claimed.

In addition, applicant's claimed "generating output utilizing the hardware graphics pipeline" (see independent Claims 1, 10, 11, 28, and 29), provides for the generation of a tangible result. Furthermore, applicant respectfully asserts that "sampl[ing] a texture map to generate a modified local area of textures" (see independent claims-emphasis added), as claimed, also clearly produces a tangible result.

With respect to Claims 1-2, 4-5, and 7-31, the Examiner has rejected the same under 35 U.S.C. 103(a) as being unpatentable over Rumpf ("Using Graphics Cards for Quantized FEM Computations"). First, the Examiner has argued that "the art of Rumpf teaches using a graphics hardware pipeline to solve partial differential equations" and that therefore "implementing any known method of solving a partial differential equation using a hardware graphics pipeline would have been obvious."

Applicant respectfully disagrees, and asserts that Rumpf merely teaches "a graphics hardware solver for the linear heat equation" (Section 6, first column, paragraph

1) with "a defined linear system of equations… [that] have [been] shown to be able to [be] solve[d]… in graphics hardware" (Section 6, second column, paragraph 4). Furthermore, Rumpf teaches that "we had to approximate all involved nonlinear functions by linear in the implementation of the anisotropic diffusion" which "leads to an deterioration in image quality in the following timesteps," and that "the restricted precision of bits per color component leads to unsatisfying results for the linear heat equation, because smooth transitions in temperature produce very small values in the convolution, with very high relative errors" (Section 8, second column, paragraph 3 – emphasis added).

Clearly, the disclosure of having to approximate all nonlinear functions with linear functions which lead to a deterioration in image quality, in addition to a restricted precision of bits per color component which lead to unsatisfying results and very high relative errors for the linear heat equation, as in Rumpf, simply fails support the Examiner's argument that it would be obvious to implement "any known method of solving a partial differential equation using a hardware graphics pipeline." Applicant thus formally requests a specific showing of the subject matter in ALL of the claims in any future action. Note excerpt from MPEP below.

> "If the applicant traverses such an [Official Notice] assertion the examiner should cite a reference in support of his or her position." See MPEP 2144.03.

Second, the Examiner has argued that "since a graphics pipeline performs numeric calculation, it is inherent in the device that it can be used to solve a partial differential equation." Applicant respectfully disagrees and again asserts that Rumpf's disclosure of "a deterioration in image quality," in addition to "unsatisfying results and very high relative errors," fails to support the Examiner's inherency argument. Thus, in view of the arguments made hereinabove, any such inherency argument has been adequately rebutted, and a notice of allowance or a specific prior art showing of such claim features, in combination with the remaining claim elements is respectfully requested. (See MPEP 2112)

Further, in response, applicant asserts that the fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993); *In re Oelrich*, 666 F.2d 578, 581-82, 212 USPQ 323, 326 (CCPA 1981). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'" *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999).

Still yet, the Examiner has rejected Claims 1-2, 10-18, 22-23, and 27 under 35 U.S.C. 103(a) as being unpatentable over Press et al. ("Numerical Recipes in Fortran 77"), in view of Rumpf et al. ("Using Graphics Cards for Quantized FEM Computations"). In addition, the Examiner has rejected Claims 19-21 under 35 U.S.C. 103(a) as being unpatentable over Press, in view of Rumpf, and in further view of Roy-Chowdhury ("Algorithm-Based Error-Detection Schemes for Iterative Solution of Partial Differential Equations"). Furthermore, the Examiner has rejected Claims 26, 28, and 30-31 under 35 U.S.C. 103(a) as being unpatentable over Press et al. ("Numerical Recipes in C"), hereinafter Press2, in view of Rumpf. Moreover, the Examiner has rejected Claim 29 under 35 U.S.C. 103(a) as being unpatentable over Press2, in view of Roy-Chowdhury, and in further view of Rumpf.

Applicant respectfully disagrees with such rejections, especially in view of the amendments made hereinabove to the independent claims. Specifically, applicant has amended at least some of the independent claims to at least substantially include the subject matter of former dependent Claims 16, 19, and 21, such that each of the independent claims now at least substantially recites the subject of such dependent claims.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaeck*,947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir.1991).

With respect to the first element of the *prima facie* case of obviousness, the Examiner has stated that "the motivation to use the art of Rumpf with the art of Press would have been the benefits recited in Rumpf that the presented strategy opens a wide area of numerical applications for hardware acceleration (***first page, Abstract, first paragraph***), and turns a graphics card into an ultrafast vector coprocessor (***first page, Abstract, first paragraph***), which would have been recognized by the ordinary artisan as benefits that allow faster processing." Applicant respectfully disagrees with this proposition, especially in view of the vast evidence to the contrary.

For example, Press relates to implementing mathematics in software, while Rumpf relates to using graphics cards for quantized FEM computations. To simply glean features from a system for performing quantized FEM computations using graphics cards, such as that of Rumpf, and combine the same with the *non-analogous art* of software-implemented mathematics, such as that of Press, would simply be improper. Graphics cards provide broad access to graphics memory and parallel processing of image operands (see the Abstract of Rumpf), while software-implemented mathematics merely relates to using software to carry out mathematical operations. "In order to rely on a reference as a basis for rejection of an applicant's invention, the reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned." In re Oetiker, 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992). See also In re Deminski, 796 F.2d 436, 230 USPQ

313 (Fed. Cir. 1986); In re Clay, 966 F.2d 656, 659, 23 USPQ2d 1058, 1060-61 (Fed. Cir. 1992). In view of the vastly different types of problems software-implemented mathematics addresses as opposed to graphics cards, the Examiner's proposed combination is clearly inappropriate.

In addition, applicant respectfully asserts that the software mathematics of the Press and Press2 references are implemented using "Fortran 77" and "C" (see respective Titles), but are not disclosed to be directly on a graphics card. For example, Page 860 of Press discloses implementing "a routine for SOR with Chebyshev acceleration" in Fortran. Further, Rumpf discloses having to "approximate all involved nonlinear functions by linear in the implementation of the anisotropic diffusion" which "leads to an deterioration in image quality in the following timesteps," and that "the restricted precision of bits per color component leads to unsatisfying results for the linear heat equation... with very high relative errors" (Section 8, second column, paragraph 3 – emphasis added). Again, applicant respectfully asserts that the Examiner's proposed combination is clearly inappropriate in view of the vastly different types of problems addressed by software-implemented mathematics as opposed to those addressed by graphics card-implemented quantized FEM computations.

Furthermore, Rumpf discloses that "many numerical algorithms still disregard hardware issues and little humps in the graphics hardware **still obstruct the passage to general fast numerical computations**" (Section 1, Goals, paragraph 4 – emphasis added). Applicant asserts that Rumpf's disclosure that many algorithms disregard hardware issues and that graphics hardware obstructs passage to general fast numerical computations clearly *teaches away* from the software-implemented general mathematics of the Press references. *In re Hedges, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986).*

Applicant respectfully asserts that at least the first element of the *prima facie* case of obviousness has not been met, since it would be *unobvious* to combine the references, as noted above.

Nevertheless, despite such paramount deficiencies and in the spirit of expediting the prosecution of the present application, applicant has at least substantially incorporated the subject matter of former Claims 16, 19, and 21 into at least some of the independent claims.

With respect to the subject matter of former Claim 16 (now at least substantially incorporated into at least some of the independent claims), the Examiner has relied on Page 855 from the Press reference to make a prior art showing of applicant's claimed technique "wherein the processing further includes determining whether the solution has converged" (see this or similar, but not necessarily identical language in at least some of the independent claims).

Applicant respectfully disagrees and asserts that the excerpt from Press relied upon by the Examiner merely discloses that "the algorithm consists of using the average of u at its four nearest-neighbor points on the grid" and that "[t]his procedure is then iterated until convergence." However, averaging u at it's four nearest-neighbor points until convergence, as in Press, simply fails to suggest a technique "wherein the processing further includes determining whether the solution has converged" (emphasis added), as claimed by applicant. Clearly, repeating the averaging until convergence, as in Press, simply fails to even suggest that "processing further includes determining whether the solution has converged" (emphasis added), where the processing "utiliz[es] the hardware graphics pipeline," in the context as claimed by applicant (see the same or similar, but not necessarily identical language in the independent claims, for context).

Further, with respect to the subject matter of former Claim 19 (now at least substantially incorporated into at least some of the independent claims), the Examiner has relied on Page 400 from the Roy-Chowdhury reference to make a prior art showing of applicant's claimed technique "wherein the determining whether the solution has converged includes calculating errors" (see this or similar, but not necessarily identical language in at least some of the independent claims).

Applicant respectfully asserts that the excerpt from Roy-Chowdhury relied upon by the Examiner merely discloses that "[t]he expressions for updating errSR_ and errSB_ in each iteration... may be derived by summing over all red and black points." Further, Roy-Chowdhury discloses that "wherever error bounds for individual elements of u[i][j] arise in our error expressions, we drop them." However, the mere disclosure of updating errSR_ and errSB_ in each iteration, and dropping error bounds for individual elements when they arise in the error expressions, as in Roy-Chowdhury, simply fails to suggest a technique "wherein the determining whether the solution has converged includes calculating errors" (emphasis added), as claimed by applicant.

Additionally, with respect to the subject matter of Claim 21 (now at least substantially incorporated into at least some of the independent claims), the Examiner has relied on Page 400 from the Roy-Chowdhury reference to make a prior art showing of applicant's claimed technique "wherein the determining whether the solution has converged further includes concluding that the solution has converged if the error is less than a predetermined amount." Applicant respectfully points out that, as currently amended, at least some of the independent claims now claim a technique "wherein the determining whether the solution has converged further includes concluding that the solution has converged based on the calculation of the errors" (see this or similar, but not necessarily identical language in at least some of the independent claims).

Applicant respectfully asserts that the excerpt relied on by the Examiner fails to meet applicant's claim language, as amended. For example, the excerpt from Roy-Chowdhury relied upon by the Examiner merely discloses that "[t]he expressions for updating errSR_ and errSB_ in each iteration... may be derived by summing over all red and black points." Further, Roy-Chowdhury discloses that "wherever error bounds for individual elements of u[i][j] arise in our error expressions, we drop them." However, the mere disclosure of updating errSR_ and errSB_ in each iteration, and dropping error bounds for individual elements when they arise in the error expressions, as in Roy-Chowdhury, simply fails to suggest a technique "wherein the determining whether the

solution has converged further includes concluding that the solution has converged based on the calculation of said errors" (emphasis added), as claimed by applicant.

Furthermore, applicant notes that Row-Chowdhury discloses that "[i]n this paper, we develop low-overhead, error-detecting versions of iterative algorithms for solving the regular, spare linear systems which arise from discretizations of various partial differential equations (PDEs)" (Page 394, second column – emphasis added). Clearly, disclosing error-**detecting** versions of iterative algorithms, as in Row-Chowdhury, simply fails to even suggest "concluding that the solution has converged based on the calculation of said errors" (emphasis added), in the manner as claimed by applicant.

Still yet, with respect to independent Claims 28 and 29, applicant respectfully asserts that such claims are deemed novel in view of the prior art excerpts relied on by the Examiner for at least substantially the same reasons argued above. For example, Claim 28 recites "determining whether the solution has converged," as claimed, which is clearly not met by the prior art reference excerpts relied on by the Examiner, as noted above. In addition, Claim 29 recites "determining whether the solution has converged by: calculating errors, summing the errors, and concluding that the solution has converged if the sum of errors is less than a predetermined amount," as claimed, which is also clearly not met by the prior art reference excerpts relied on by the Examiner, for substantially the same reasons as noted above.

To this end, applicant respectfully asserts that at least the first and third elements of the *prima facie* case of obviousness have not been met, since it would be *unobvious* to combine the references, as noted above, and the prior art reference excerpts, as relied upon by the Examiner, fail to teach or suggest all of the claim limitations, as noted above. Thus, a notice of allowance or a proper prior art showing of all of applicant's claim limitations, in combination with the remaining claim elements, is respectfully requested.

Applicant further notes that the prior art is also deficient with respect to the dependent claims. For example, with respect to Claim 18, the Examiner has relied on

Page 855 from the Press reference to make a prior art showing of applicant's claimed technique "wherein it is determined whether the solution has converged after a predetermined number of multiple iterations of the relaxation operation."

Applicant respectfully asserts that the excerpt from Press relied upon by the Examiner merely discloses that "the algorithm consists of using the average of u at its four nearest-neighbor points on the grid" and that "[t]his procedure is then iterated until convergence." Further, Press discloses that "[t]his method is in fact a classical method... called *Jacobi's method*." However, averaging u at it's four nearest-neighbor points until convergence, as in Press, simply fails to suggest a technique "wherein it is determined whether the solution has converged after a **predetermined number** of multiple iterations of the relaxation operation" (emphasis added), as claimed by applicant. Clearly, the mere disclosure of iterating until convergence, as in Press, simply fails to even suggest "a predetermined number of multiple iterations" (emphasis added), in the manner as claimed by applicant.

Further, with respect to Claim 22, the Examiner has relied on Pages 862-868 in Press to make a prior art showing of applicant's claimed technique "wherein if it is determined that the solution has converged, repeating the processing using an altered parameter value." Specifically, the Examiner has argued that "it would have been obvious [that] altering a grid size is altering a parameter."

Applicant respectfully disagrees. Press explicitly discloses the "multigrid as an iterative scheme, where one starts with some initial guess on the finest grid and carries out enough **cycles**...to achieve convergence," and that the "simplest way to use multigrid...[is] to apply enough **cycles** until some appropriate convergence criterion is met" (see Page 868-Full Multigrid Algorithm-emphasis added). In fact, applicant notes that Press even teaches that "[o]ne iteration of a multigrid method, from finest grid to coarser grids and back to finest grid again, is called a *cycle*" (see Page 865).

Thus, Press clearly discloses carrying out multiple cycles, where each cycle utilizes a plurality of different grid sizes, in order to achieve convergence, which simply does not support the Examiner's argument that "it would have been obvious [that] altering a grid size is altering a parameter," especially in view of applicant's claimed technique, namely "wherein if it is determined that **the solution has converged**, repeating the processing using an altered parameter value" (emphasis added), as claimed. Again, applicant formally requests a specific showing of the subject matter in ALL of the claims in any future action. See MPEP 2144.03.

Again, since at least the first and third elements of the *prima facie* case of obviousness have not been met, as noted above, a notice of allowance or specific prior art showing of each of the foregoing claim elements, in combination with the remaining claimed features, is respectfully requested.

To this end, all of the independent claims are deemed allowable. Moreover, the remaining dependent claims are further deemed allowable, in view of their dependence on such independent claims.

In the event a telephone conversation would expedite the prosecution of this application, the Examiner may reach the undersigned at (408) 505-5100. The Commissioner is authorized to charge any additional fees or credit any overpayment to Deposit Account No. 50-1351 (Order No. NVIDP074).

Respectfully submitted,
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